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Assessment of three different asexual propagation techniques for improved vegetative growth of guava (*Psidium guajava* L.)

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Guava is one of the most important fruit crops being cultivated throughout the world. Guava is generally propagated through seeds which result in heterozygosity and the desirable characters are not often transferred from parent plant to offspring. In order to get true to type plants, several asexual techniques such as T-grafting, T-budding, cleft grafting, aerial layering or inarching are locally adapted. In order to assess the effectiveness of T-grafting, T-budding, cleft grafting, present research was carried out on guava cv. Surahi, in different months i.e., February, March, September and October. Parameters included success percentage (%), days taken to sprout shoot length (cm) and number of leaves. The results showed that maximum success percentage was found in T-grafted plants carried out in the months of September and October, whereas, minimum days taken to sprout were observed in T-budded plants in February. Maximum shoot length and number of leaves were observed in T-budded and T-grafted plants in the months of February and October, respectively.
Keywords: Budding; grafting; vegetative growth; plant propagation; tropical fruit.

INTRODUCTION

Guava (*Psidium guajava)* is well-known as "the apple of tropics" or "poor man's fruit". Guava is considered as one of the attractive, nutritionally valuable and remunerative crop (Singh *et al.,* 2000). Guava fruits are rich in nutritional value; whereas, tree carries heavy crop (twice a year) and gives high economic return (Singh *et al.,* 2000). Therefore, many growers have taken up guava orcharding on commercial scale (Anonymous, 2022). Its fruits have a distinct aroma and flavor which is appealing to many people. It is consumed in both fresh and processed form increasing to its versatility in culinary uses. The guava fruits have been known to contain high vitamin C (ranging from 90 mg to 100 g of fruit pulp) along with other minerals and organic acids (Naseer *et al.,* 2018).

Guava is the fourth most important fruit crop of Pakistan being cultivated on an area of 52,462 ha with annual production of 48,8017 tonnes (Anonymous, 2016). Guava is highly cross pollinated in nature (35.6%) and is commonly propagated through seeds (Qadri *et al.,* 2018). The plants arising from seeds are not reliable as they are not identical to their parents. Desired traits can only be reproducible through clonal propagation (Singh *et al.,* 2005). Vegetative/clonal propagation is carried out through various traditional methods such as cutting, buddings, grafting, aerial layering or inarching or by adapting latest mode of multiplication i.e., micropropagation (Zamir *et al.,* 2007).

Non-availability of quality planting materials had adversely affected the guava production and productivity (Singh *et al.,* 2005). A rapid and successful propagation technique is required that will make guava planting material available throughout the year for successful plantation. For this purpose, rapid methods of propagations are very necessary particularly in case of less planting materials. Asexual propagation result in true to type guava plants with a short infantile phase. Although various asexual techniques are being practiced in guava like air layering (Qadri *et al.,* 2018; Manna *et al.,* 2004), budding (Abbas *et al.,* 2013; Darwesh *et al.,* 2013), stooling (Gollagi *et al.,* 2019) and inarching (Qadri *et al.,*2018; Ali, 2018), but these are not commercially viable because of varying rate of success, absence of tap root system and cumbrous process (SamiUllah *et al.,* 2004; Singh *et al.,* 2005). While choosing a proper technique for propagation in guava, the climatic conditions, time of carrying out practice and method should be taken in consideration (Sharif *et al.,*

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2015). To produce quality guava plants over a small period of time the vegetative propagation techniques needed to be investigated in local condition (Faisalabad, Pakistan). Therefore, the present research was designed to compare different vegetative propagation techniques, carried out in different months to optimize the best time and method for plant propagation.

MATERIALS AND METHODS

The experiment was conducted in the Nursery area of Horticultural Research Institute, Ayub Agriculture Research Institute, Faisalabad, Pakistan (31°404'N; 73°048'E) during the year 2017-20.

***Plant Material*:** In this experiment, guava (*Psidium guajava* L.) cv. 'Surahi' was budded and grafted on guava cv. 'Gola' rootstock in field conditions. The rootstocks were raised from seeds sown in polythene bags. The polythene bags were filled with sand, silt and clays at ratio of 1:1:1. The rootstock were grown until they attained pencil thickness (20-30 mm). Almost, after twelve months the rootstocks were ready for budding and grafting operations. The scion bud and stock were selected from the mother plant (healthy and disease free) on the day of grafting. The bud was detached using sharp and sterilized budding knife and secateurs. The plants were T-budded, T-grafted and cleft grafted during the month of February, March, September and October, respectively. Seedlings were sprayed with insecticide (Triazophos @2.5 mL/ L water) and fungicide (Topsin-M Thiophinate Methyl @ 2 g/ L water) for protection against insect, pests and fungus, respectively. All other cultural practices followed were same for the treatments.

***Treatments*:** Treatments selected for the experiment were viz., T_1= T-budding, T_2= T-grafting and T_3= Cleft grafting. Data regarding success percentage (%), days taken to sprouting, length of shoot after 60 days and numbers of leaves were taken after budding and grafting operations in each respective month. The observation on data success percentage and days taken to sprout was measured on weekly basis after budding and grafting procedures (Sharif *et al.*, 2015). Shoot length was measured using regular measuring scale and putting it on the point above scion (budded or grafted) after 60 days of respective months (February, March, September and October) (Sharif *et al.*, 2015). Numbers of leaves were counted after sprouting of leaves.

***Statistical analysis*:** Experimental design was laid out in split plot design taking month as an additional factor to study their interaction with three treatments. In each replication 15 plants were selected. Total 180 were budded/grafted in each season, respectively. Data were analyzed statistically by using Statistix-10 Software, a computer package for statistical analysis and difference among treatments were compared using Tukey's Honestly Significant Difference Test at 5% probability level (Steel *et al.*, 1997).

RESULTS

The results showed that among different grafting techniques practiced on guava cv. Surahi, T-grafting showed maximum success % in all three years 2017-20 (Table 1). The results showed that maximum success in guava cuttings was showed by T-grafting carried out during the month of October (54%)

Table 1. Effect of three different asexual propagation techniques carried out during different months on Success percentage of guava cv. 'Surahi'.

Propagation methods	Propagation months				Mean
	September	October	February	March	
T-Budding	24.50e	26.75e	45.58b	37.83cd	33.66B
T- Grafting	51.00ab	54.16a	41.75c	35.83d	45.68A
T-Cleft Grafting	11.00f	9.66f	10.41f	10.00f	10.27C
Means	28.83AB	30.19AB	32.58A	27.88B	

Means within column followed by same letter are non-significant at $p \leq 0.05$.

Table 2. Effect of three different asexual propagation techniques carried out during different months on number of days taken to sprout by guava cv. 'Surahi'

Propagation methods	Propagation months				Mean
	September	October	February	March	
T-Budding	29.16ef	29.50def	23.33f	24.08f	26.50C
T- Grafting	34.75cd	36.50bc	33.00cde	30.58cde	33.70B
T-Cleft Grafting	44.33a	46.91a	31.16cde	41.58ab	41.00A
Means	36.08AB	37.63A	29.16C	32.08BC	

Means within column followed by same letter are non-significant at $p \leq 0.05$.

Table 3. Effect of three different asexual propagation techniques carried out during different months on Shoot length (cm) after 60 days of guava cv. 'Surahi'.

Propagation methods	Propagation months				Mean
	September	October	February	March	
T-Budding	15.57d	13.84d	28.77ab	18.37c	19.14B
T- Grafting	30.91a	27.61ab	26.75ab	24.23b	27.37A
T-Cleft Grafting	11.48de	10.96e	12.39d	11.37de	11.55C
Means	19.32B	17.47B	22.64A	17.99B	

Means within column followed by same letter are non-significant at $p \leq 0.05$.

Table 4. Effect of three different asexual propagation techniques carried out during different months on number of leaves of guava cv. 'Surahi'

Propagation methods	Propagation months				Mean
	September	October	February	March	
T-Budding	12.50d	13.50cd	23.75a	12.66d	15.61B
T- Grafting	19.91b	20.97ab	20.58ab	15.83c	19.32A
T-Cleft Grafting	9.66e	9.08e	13.00cd	9.25e	10.25C
Means	14.02B	14.50B	19.11A	12.58B	

Means within column followed by same letter are non-significant at $p \leq 0.05$.

and September (51%). Likewise, best month to carry out budding/grafting was February (32%) followed up by October (30%) and September (28%), respectively (Table 1).

In guava plants various asexual propagation techniques showed significant difference for days taken to sprout (Table 2). Minimum days taken to sprout were taken by plants that are T-budded during the month of February (23 days) (Table 2). Similarly, T-budding in guava plants showed minimum days to sprout (26.5) (Table 2), whereas cuttings planted during February showed minimum days for emergence (29.6 days) (Table 2).

Shoot length after 60 days showed significant difference among treatments. The maximum shoot length was observed in plants practiced T-grafting (27.37 cm) during the month of February (22.64 cm) (Table 3).

Number of leaves in guava plants showed significant difference among treatments. It was observed that maximum number of leaves were displayed by the plants which are budded/grafted in the month of February (19.11), whereas among various treatments T-grafted plants showed highest number of leave (19.32) (Table 4).

DISCUSSION

The results showed that significant variations exist among these three different asexual propagation techniques in term of all studied parameters. The plants with T-grafting carried out in the month of February showed the highest success rate (Table 1). This might be due to availability of sufficient time to develop compatibility for each other. Moreover, the cambium activity might also increase as their dormancy broke so ultimately resulted in maximum success rate and subsequent growth. New callus is initiated from the cambium tissue and its activity is improved because of high temperature and low humidity (TahseenUllah *et al.,* 2005; Thapa and Rawat, 2020). The results are in line with the findings of Abbas *et al.* (2013) who observed maximum success percentage in T-grafted plants of guava. Likewise, the success percentage of union was also found in T-grafted plants of Ber (Sharif *et al.,* 2015), jackfruit (Jose and Valasalakumari, 1991), Jamun (Chovatia and Singh, 2000; Rani *et al.,* 2018) and mango (Chovatia and Singh, 2000).

Number of days taken to sprouting of guava was also influenced by the interaction of time and the methods of propagation. T-budding during the month of February took least number of days to sprout. During the month of February-March endodormancy breaks and maximum cambium activity take place which result in favorable conditions for the bud wood union. The results are in line with the findings of Abbas *et al.* (2013), who found that T-budding took minimum days to sprout in guava plant. High humidity and mild temperatures during the month of February and March are reason for more success in grafting (Prasanth *et al.,* 2007; Naik and Kumar, 2020). Similarly, a smaller number of days to sprout were taken by Ber plants (Sharif *et al.,* 2015), mango (Munde *et al.,* 2011), carambola (star fruit) (Sonawane *et al.,* 2012), sapota (Pampanna and Sulikeri, 2000), jamun (Bandenawaj, 2007) and amla (Saroj *et al.,* 2000) when they are grafted or budded. However, Rani et al. (2015) witnessed that air layering during the month of august in guava plants result in early sprouting compared to other treatments.

Shoot length in guava plants was also influenced by propagation method used. The results are supported by the finding of Abbas *et al.* (2013), who observed maximum shoot length after 60 days in guava plants which were T-grafted. Similarly, maximum scion length was measured in T-grafted

Ber plants in month of April-May (Sharif *et al.,* 2015). Maximum shoot length in guava plants was observed in budded (Khattak *et al.,* 2002) and grafted (Gotur *et al.,* 2017) plants. Similar results were also observed in mango (Naik and Kumar, 2020), Cashew nut (Gadekar *et al.,* 2010) and jamun (Angadi and Karadi, 2012).

The interaction between grafting techniques and months has significant effect on the number of leaves of guava plant. The increase in number of leaves is influenced by environmental conditions such as optimum temperature, relative humidity and sufficient sunlight which ensured more meristematic activity during month of February and early healing of graft union during this month (Gotur *et al.,* 2017; Prakash *et al.,* 2018). Similarly, highest number of leaves after grafting were observed in guava (Abbas *et al.,* 2013), ber (Sharif *et al.,* 2015), jamun (Bandenawaj, 2007), litchi (Li *et al.,* 2014) and bael (Giri and Lenka, 2009).

***Conclusion*:** Heterozygosity is a serious issue in propagation of guava through seeds. To maintain the desirable traits of mother plant, asexual multiplication is recommended. Among different asexual propagation techniques tested in guava like T-grafting and T-budding during the months of October and February showed comparatively higher success percentage, early sprouting, shoot length and number of leaves, respectively.

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***Authors' contributions*:** Malik Mohsin Abbas, Maryam Nasir: Designed the experiment, collected data and prepared the manuscript; Malik Allah Bakhash: Done proof reading; Nida Mehreen: Done statistical analysis; Maaz Aziz: Reviewed the paper; Sitwat Riaz: Assisted in design layout and data collection; Zaid Mustafa: proof reading; Sahar Rasheed and M. Amna Jamil Kanwal: Assisted in research work.

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